Teaching Reform for Curriculum Computer Networks Based on MOOCs

Feng Jian, Tian Hongpeng, Cui Haiwen, Liang Rong, Bai Yun

Abstract—In the background of educational globalization and informationalization, MOOCs not only brought a new revolution of knowledge dissemination and educational popularize, but also brought many new opportunities and challenges for higher education. The characteristics of computer networks curriculum and problems in traditional classroom teaching are analysed, difficulties of constructing the curriculum into a MOOC are presented, procedures and guidelines of how to construct the curriculum into a MOOC are proposed, and the concrete measures are given from the aspects of the course contents, learning activities and teaching evaluation. It's aiming to explore the law of MOOCs construction and to improve teaching level and quality of teachers of computer network curriculum.

Index Terms—MOOCs; Computer Networks; Curriculum System

I. INTRODUCTION

Since 2012, Massive Open Online Courses (MOOCs) began to develop rapidly around the world. It attracted a large number of learners and widespread concern in the field of global higher education. Many famous universities in the world are carrying out MOOCs teaching, and build a large number of platforms for MOOCs by adopting open, shared, interactive teaching mode, which typically have Coursera, Udacity and edX, carrying a high-quality education resources from the world's elite. From 2013, the domestic educational community began to take its own pace on the road of MOOCs construction by exploring education model of MOOCs, developing MOOCs courses and put them on-line, and organizing a number of seminars about MOOCs. While the domestic teaching platforms for MOOCs have emerged, such as Netease open class and Guokr network [1]. As a new online education model, although there are still many problems and shortcomings, MOOCs still have broad prospects for development for its unique advantages.

Computer Networks is a core course of computer-related professions in universities, and it is also one of the test subjects of unified examination for postgraduate enrollment of computer-related professions, plays a very important role in the knowledge system of computer class. Combining the concepts and methods of two disciplines - computer and

Feng Jian, College of Computer Science & Technology, Xi'an University of Science and Technology, Xi'an, China, Phone No. 86-2983858048

Tian Hongpeng, College of Computer Science & Technology, Xi'an University of Science and Technology, Xi'an, China, Phone No. 86-2983858048Cui Haiwen, College of Computer Science & Technology, Xi'an University of Science and Technology, Xi'an, China, Phone No. 86-2983858048

Liang Rong, College of Computer Science & Technology, Xi'an University of Science and Technology, Xi'an, China, Phone No. 86-2983858048

Bai Yun, College of Computer Science & Technology, Xi'an University of Science and Technology, Xi'an, China, Phone No. 86-2983858048,

communication and characterized by sound theoretical basis, feasible applicability, broad knowledge and rapid innovation of knowledge and technology, the curriculum forms its own independent course system and propose high request to teachers to have sufficient knowledge reserve and stand on the frontier of the development of Internet technology. For important course such Computer Network, how to carry out teaching reform with MOOCs and improve teaching effectiveness are our concern recently.

II. DIFFICULTIES IN COURSE CONSTRUCTION

A. Current teaching Situation of Computer Networks

Since many domestic universities are taking advantage of MOOCs to reform teaching method, some computer courses had completed construction of MOOCs. Traditional Computer Network course generally use a combination of classroom instruction and hands-on practice in the way teaching. Teachers in the classroom spend a lot of time to explain complex knowledge, but because class hour is limited, the students cannot fully absorb the knowledge, and there is no good interaction in the classroom, students lack enthusiasm for learning and active participation awareness, all these are not conducive to cultivate creative talents with innovative thinking ability. At the same time the issue of emphasizing theory and neglecting practice often occurs, namely the experimental teaching is relatively weak. In addition, as the knowledge of computer networks update rapidly, the issue that teaching contents are not updated in a timely manner occurs sometimes. If teaching ideas of MOOCs can be used into course teaching, for example, teachers can provide relevant teaching video resources for students to preview before class, arrange practice combining training video, organize interactive discussion, explain key points to deepen students' understanding, and then attract and inspire students' interest through practice in the course, and then teaching effect will be significantly improved.

B. Difficulties in Transforming to MOOCs

MOOCs swept the world in a short time, thanks to its three characteristics: ① Good interaction. What MOOCs emphasizes is the interaction between teachers and students in learning process, rather than simply making the whole course video. MOOCs encourage and urge the students to actively participate in the teaching process. ② Fragmentation of learning. Through breaking the traditional concept of teaching hours, MOOCs makes knowledge to little fragments, and offers videos with short length, usually a few minutes. This is not only conducive to learners to focus on, but also convenient for learners to use fragmented time to learn anytime and anywhere. ③ MOOCs can achieve a good learning systemization. Although knowledge in MOOCs is fragmented, it is self-contained too. Teachers should make

each MOOCs become a relatively independent and complete education system through sorting knowledge points to through, arranging course elements such as video, exercises, discussions and examinations systematically and reasonably, as well as analyzing course data scientifically. But there are still many difficulties in the construction of MOOCs to achieve above three points.

a) Old concepts of teachers

Most teachers accustomed to the traditional face to face teaching, they are not used to online teaching. If they do not learn teaching ideas of MOOCs profoundly and learn successful practice of MOOCs, they will build MOOCs to small classroom teaching, cannot change feel of the learners fundamentally and cannot realize true flipped classroom.

b) Low quality of teaching

Currently construction of MOOCs is not mature enough, theories of instructional design are abstract and macro, choices of curriculum content and design of teaching process are totally dependent on the level of teachers, workable instructional model are lack, all these result in mixed quality of the course. At the same time, student-teacher ratio in MOOCs is much larger than the traditional classroom teaching, measures to ensure the quality of teaching is not perfect, the public have also questioned these problems. Faced with these problems, on the one hand requires a high level of teachers who can arrange teaching progress reasonable, on the other hand also requires course be more stringent regulation.

c) Huge loss of learners

Since almost all of the MOOCs platforms adopt totally open and free registration mode, lacking of effective means of restraint, many learners rush to register, but give up learning when enthusiasm faded after a period of study, resulting in a huge loss of learners. Problem of learners loss reflect issues of design and regulatory in actual teaching process. For learners, online learning needs to be able to adhere relying on willpower. How to stimulate learners to produce stronger motivation in the learning process is an important problem, and it needs to design comprehensive workable solutions considering from curriculum convergence design, interaction, learning resources and environment design, effective supervision, evaluation and other aspects.

C. MOOCs Transformation Process

a) Understanding philosophy of MOOCs

Different from traditional classroom teaching, MOOCs adopts a new teaching philosophy. On the one hand, Teachers involved in MOOCs should follow the construction of heritage, that is to say, they should learn from experiences under the framework of traditional education teaching methods, teaching design and other aspects and fully use existing educational resources such as instructional design models and case studies with high quality, on the other hand, through establishing new concepts, learning from the advanced experience of the existing class of MOOCs, and participating in seminars or exchange activities in the construction of MOOCs, they should improve the understanding of MOOCs, learn innovative approaches, to

really learn from others and to promote the teaching quality and improve the quality of personnel training.

b) Organizing and constructing teaching team

A clear, informative, rich performance MOOCs needs to be completed by a teaching team. Establish a good working mechanism is an important work in MOOCs construction. In the process of team organization and integration, organizers of MOOCs should pay attention to the structure of the composition of the team members, do good job assignments, play a good bridge and link role to initiatively promote the integration of the team members. By MOOCs construction, a cohesive and high teaching level teaching team should be organized, and teaching level and collaboration capabilities of the team members should be enhanced.

c) Organizing and monitoring teaching process

In the construction of MOOCs, you must understand audience and main characteristics of the course, in order to determine the course objectives and knowledge framework. Then clarify teaching ideas, comb knowledge points, namely complete fragmentation of knowledge. Here the relevance of knowledge points must deal with carefully, especially in separating knowledge to clusters, blocks and points, establishing relation network model between the knowledge points, and forming knowledge system of course. Finally make plan of showing way of knowledge, that is to say, for specific knowledge points, design video, exercises, discussions, lectures and the number of all these elements and orders, consider the constraints and incentives for learners, deliver and strengthen process evaluation and personalized learning-oriented services for different types, levels of learners, and change teaching philosophy and teaching methods of teachers and learning styles of learners. In this process, it should keep hammering away and strive to perfect.

III. MOOCs Practice for Computer Network Curriculum

A. Construction Goals of the Course

As a curriculum with wide audience, the construction goal of computer network curriculum is to build it to a basic course for learners who have certain foundation in computer. Course contents cover basic concepts, basic principles, basic methods, basic skills, typical cases, integrated applications, cutting-edge topics and hot issues in the field of network technology, and have unique teaching style and advanced teaching philosophy. Through learning of the course, learners can master the basic concepts, basic principles and methods of computer networks; grasp architecture and typical protocols of computer networks; understand composition, features, working principle and typical usage of typical network devices; be able to use basic concepts, basic principles and methods of computer networks to realize analysis design and application of network systems [2], and be able to give an objective evaluation for learning outcomes through exercises, quizzes, interaction and other means.

B. Course Description

The basic principles of computer networks are fairly mature and relatively stable. Starting from the role of the computer network in the information age, the course

summarizes the development and composition of the Internet, introduces architecture of computer network, and then focuses on explaining of TCP/IP architecture. Furthermore, the basic concepts, the basic principles and the latest developments of physical layer, data link layer, network layer, transport layer and application layer are discussed in accordance with the order from bottom to top. The physical layer focuses on channel capacity, multiplexing technologies and digital transmission systems. The data link layer focuses on PPP protocol and CSMA/CD protocol and their development, and the two protocols are widely used respectively in point-to-point channel and broadcast channel, and focuses on the development of Ethernet technology. The network layer is an important part of network interconnection. Starting from the virtual interconnection network, it mainly discusses interconnection and routing of IP network. The transport layer provides end to end communication between the processes. Principles and characteristics of two parallel protocols TCP and UDP in the Internet are analyzed. Application layer are inclusive, but focuses on principles of traditional, basic and important application layer protocols, lays a solid foundation for students to further study follow-up courses related to computer network. At the same time, because the computer network is developing very fast, on the basis of teaching the basic principles of computer networks and the Internet, network security, wireless networks, IPv6 and other new contents are introduced into the course.

C. Teaching Organization

In the online course, because teachers and students are in separation of time and space, the extent of control and dominate from teachers to course learning becomes very low. Self-study and asynchronous learning of learners become very important. Learners are more dependent on teaching resources of online courses. Choice and layout of the curriculum contents, especially the design of learning activities become key factors affecting the participation degree of learners. This requires careful planning and complete teaching organization of the course.

1) Design of course contents

According to requirements of content particulates and systematization of knowledge in MOOCs, in the extraction of knowledge points, knowledge points with radiation effects should be selected to achieve the effect of fanning out from points to areas and enhancing the overall quality of teaching effectiveness. Taking example of routing protocol, Figure 1 shows radiation and leading role of routing protocol to other teaching contents in the chapter of the network layer [3]. Wherein, IP protocol, routing algorithms and routing protocols are the focus teaching contents of the chapter.

The principal of design teaching contents is to focus on combination of theories, technologies and engineering application, to highlight the basic concepts, basic principles and applications of technology, at the same time reflect applications of the theories and technologies. Specific content organization is to take network architecture as the core to organize subsequent study, focusing on building the overall concept of computer network architecture [4]; 5-layer hierarchical model of computer networks is taken in teaching, namely physical layer, data link layer, network layer, transport layer and application layer. Two main lines are used to introduce structure of the network protocol stack: the first is data encapsulation and running of each layer; the second is the

structure and operation principle of typical device in each layers. According to above concepts, the main knowledge points of Computer Networks curriculum are shown in Tab. 1.
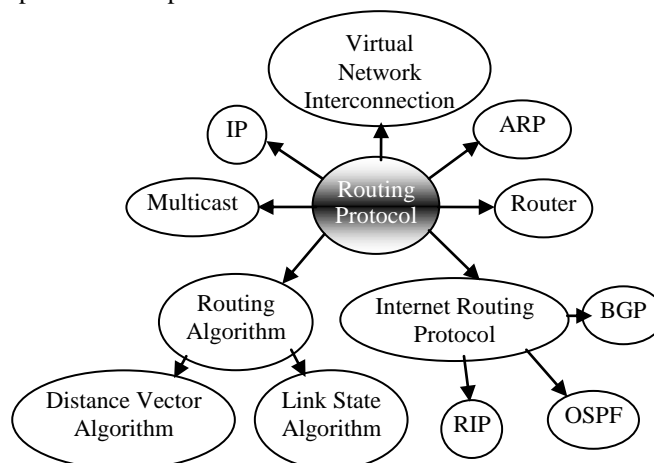

Fig. 1 The relationship between routing protocol and other knowledge points

Tab. 1 Main knowledge points in Computer Networks

Units	Main knowledge points	Equipment
Architecture	Internet History, Physical Structure, Architecture(OSI, TCP/IP), Protocol, Standard	
Physical Layer	Basic Concepts of Data Communication, Channel Multiplexing Technology, Transportation Media	Hub
Data Link Layer	PPP、Ethernet(Frame Structure, CSMA/CD, Development of Ethernet), xDSL, Physical Address	Bridge, Switch
Network Layer	Virtual Network Interconnection, IPv4(IP Address, Subnet, CIDR, Routing)、ARP、ICMP、RIP、OSPF、BGP、VPN、NAT、IGMP、IPv6	Router
Transportation Layer	Port, UDP(Packet Structure, Checksum), TCP(Packet Structure, Traffic Control, Congestion Control), Reliable transmission theory	Gateway in Transportation Layer
Application Layer	DNS、WWW、HTTP、SMTP、POP、DHCP、SMMP	Gateway in Application Layer
New Technologies	P2P, Mobile Network, Wireless Network, Multimedia Network, Network Security	Firewall

2) Learning activities

Because MOOCs have open and free learning and participation mechanisms, keeping a high degree of adhesion and attractive of the curriculum and attracting more learners to involve in the course needs a detailed design for curriculum resources and learning activities [5].

a) Preparation of teaching materials

Course materials are subject of MOOCs, including two parts of video lectures and supplementary information.

Course lectures are video units made by teachers according to chapters or topics. Each unit includes teaching videos, classroom practice, tests and their answers, guest interviews, unit tests, homework and so on. Supplementary information of course include lectures text and guest interviews text corresponding to teachers' video lectures, references or expand reading materials for each unit, web resources, homework and software required in the course study. In the course content design, the level difference among the learners should be paid special attention to. For example, when assigning homework, separate homework to low, middle and high three difficulty levels in advance, taking the different academic levels and individual needs of learners into account, laying the foundation for scientific, fair, intelligent learning evaluation at the same time.

b)   Experimental design

In the course construction of Computer Networks, experiments are essential. In the experimental design, in addition to demonstrate actual operation and specific use of transmission media and network equipment in the teaching videos, software-assisted tools such as Wireshark and Packet Tracer should also be taken advantage of [6]. For example, by using the protocol analysis tool Wireshark to capture and analyze data packet on-site, protocols will be explained intuitively and easy to be understood; by using Packet Tracer to simulate design and configuration of network environment, and to observe detailed process of data packets traveling in the network, learners can understand network operation mechanism deeply. Typical experiments include IP protocol analysis, ARP protocol analysis, ICMP protocol analysis and application, UDP protocol analysis, TCP protocol analysis, as well as configuration and use of switches, routers and firewalls.

c)   Interaction

In addition to provide rich contents, MOOCs should also provide learning support module, including aspects of interactive modules and individual learning progress and so on. This section should support self-introduction, offline convened activities, announcements, feedbacks and suggestions of the curriculum, forums classified according to themes or units, and use forums, Email, instant messaging and other ways to increase interactions between learners and teachers, learners and learners, and then encourage meet-up. In particular, the advanced experience of foreign countries can be used to strengthen support for a variety of independent communication and self-service among learners, to form into new style of teacher-student and student-student relationships in which capable learners can be teachers and learners can help each other. Individual learning progress should include homework submission of each unit, the unit test results view, etc. After the completion of the final exam, learners can view the learning achievements of various stages and print course certificates. This will stimulate motivation and upgrade courses learning autonomy.

3) Teaching evaluation

Teaching evaluation is carried out on a comprehensive assessment of variety of elements learners. Different from traditional teaching evaluation methods in domestic, MOOCs emphasizes evaluation to learning process. In the comprehensive evaluation of the performance of learners, classroom exercises, quiz, homework, unit tests and final exams are all integrated, and the results of classroom exercises just put limited impact on the total grades. This not only can help learners to test by them at any time, but also can make learners give the learned contents a comprehensive review and consolidate.

IV.   CONCLUSIONS

With the development of MOOCs, more and more countries, universities and teachers will be infected, more and more learners can enjoy the benefits of MOOCs, and its development process is an ongoing process of finding problems and solving problems. Computer Networks is a course with complex knowledge network and a huge system, transforming traditional Computer Networks teaching to MOOCs needs development teams pay a great creative work, and their overall ability to control the course is also a severe test and a chance to improve. Teachers should be encouraged to accept the challenge, combine their teaching experience to teaching philosophy of MOOCs, to improve their teaching level and teaching ability continually and to promote and accelerate the upgrading of the quality of education.

REFERENCES

[1] W. Y. Yang, L. Ma, L. Zhou, X. W. Ding. Teaching Reform of Extrude MOOC for Network Engineering Major in Local Universities [J]. Computer Education, 2015(5):24-28.

[2] H. Y. Yun, Z. G. Zhao, L. Li, X. G. Du. Discussion on the Reformation of Course Teaching on Computer Network Principle[J]. Modern Computer, 2012(32):39-43.

[3] P. Liu, M. Chen, J. Xie, W. W. Chen. Teaching Reform for the Principles of Computer Network Featuring Scientific Thinking Training[J]. Computer Education, 2011(19):51-54.

[4] B. L. Yang, W. P. Guo, S. Y. Wei, Q. C. Wang. Teaching Reform for Computer Network[J]. Electronic Sci. & Tech., 2011,11(2):122-123.

[5] Y. M. Jia, X. M. Sang. The Innovation and Development of MOOCs[J]. Educational Development Research, 2014(Z1):103-109.

[6] S. Q. Wang, D. Shao, X. H. Li. Course Design of TCP/IP Protocol for Network Engineering Major[J]. Computer Education, 2013(14):42-49.

Jian Feng Date of birth: August, 1973. She received her doctoral degree of Computer Software and Theory from Northwest University, Xi'an, China, in 2008. And research interests on computer network and communication, network security, distributed computing. She is currently an Associate Professor with College of Computer Science & Technology, Xi'an University of Science and Technology, Xi'an, China.